SPACEWAY™ Master Schedule

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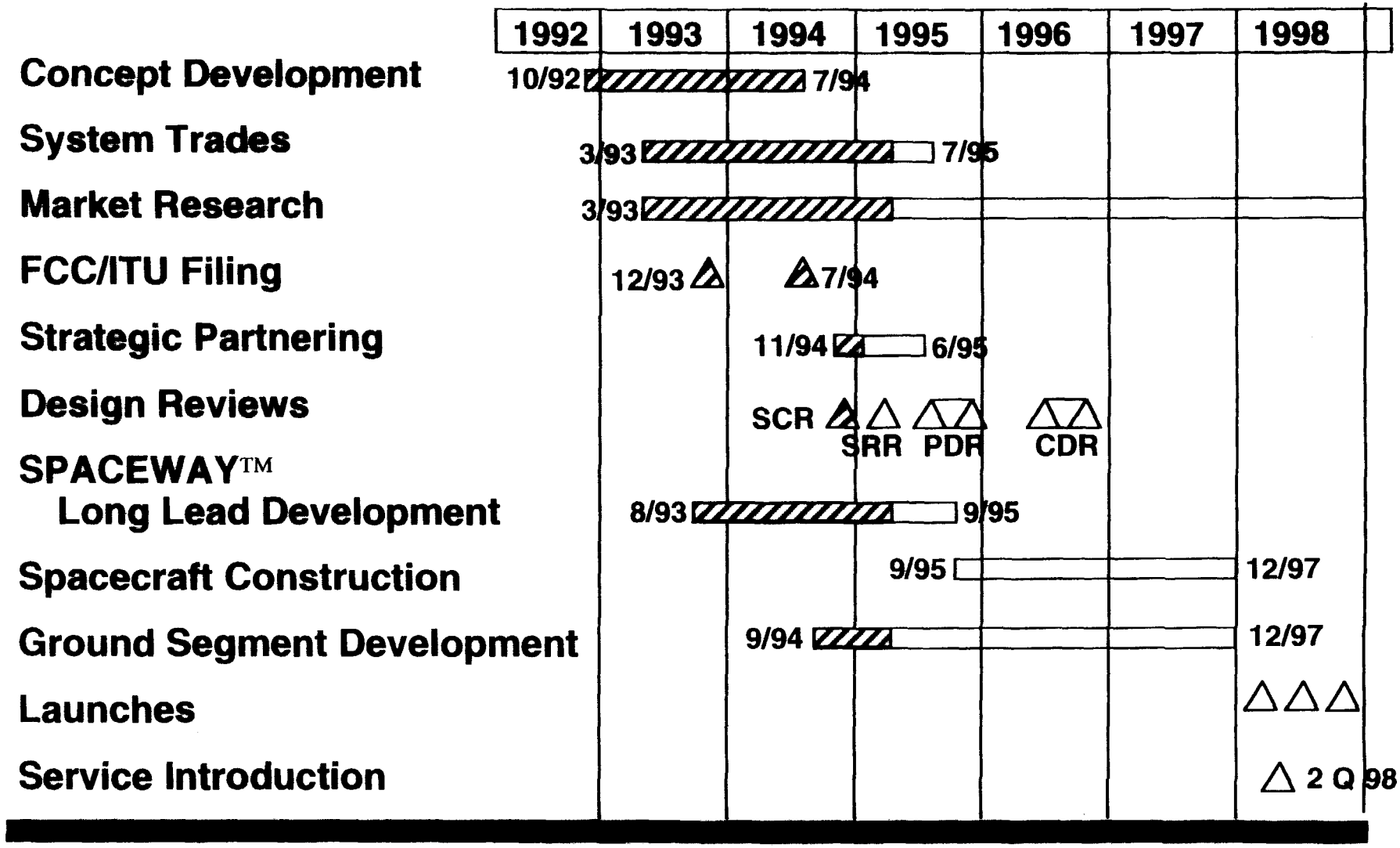
21 NOVEMBER 1994



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SPACEWAY™ Builds on Existing Hughes Technologies

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- SPACEWAY™ system uses core Hughes technologies:
  - Proven, reliable HS-601 satellite design
  - On-board digital signal processing
  - Ka-band electronics (MMICs, TWTAs, etc.)
  - Millimeter wave crosslinks
  - DIRECTV™ and VSAT network experience
- Basic technology improvements are in-place to efficiently meet SPACEWAY™ needs:
  - Low power ASIC devices
  - High performance MMICs
  - Millimeter wave LNA and power devices
  - Compact packaging of digital and RF electronics

SPACEWAY™ Summary

Evolutionary extension **of Hughes core competencies**

Affordable **on-ramp to information superhighway**

- **Bandwidth on demand with universal access**

Market driven **regional system with worldwide connectivity**

SUPPLEMENTAL MATERIALS

SPACEWAY™

Global Network

System Summary

Presented to the Pacific Telecommunications Council

Honolulu, Hawaii

25 January 1995

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16 December 1994

SPACEWAY™ System Summary

ABSTRACT

By the end of this decade, Hughes' SPACEWAY™ network will provide the first interactive "bandwidth on demand" communication services for a variety of applications. High quality digital voice, interactive video, global access to multimedia databases, and transborder workgroup computing will make SPACEWAY™ an essential component of the computer-based workplace of the 21st century. With relatively few satellites to construct, insure, and launch -- plus extensive use of cost-effective, tightly focused spot beams on the world's most populated areas -- the high capacity SPACEWAY™ system can pass its significant cost savings onto its customers. The SPACEWAY™ network is different from other proposed global networks in that its geostationary orbit location makes it a truly market driven system: each satellite will make available extensive telecom services to hundreds of millions of people within the continuous view of that satellite, providing immediate capacity within a specific region of the world.

Introduction

This paper presents a summary description of SPACEWAY™, a global network of Ka band satellites being developed by Hughes Communications, Inc., to provide worldwide telecommunication services. The SPACEWAY™ network will utilize state-of-the-art technology to introduce a broad range of innovative and affordable satellite services on a global basis to consumer and commercial end-users. The outline of principal topics addressed in this paper is as follows:

1. System concept
2. Space segment characteristics
3. Ground segment characteristics
4. Link performance objectives and power budgets

1. System Concept

The SPACEWAY™ system[1] is a network of regional systems that will utilize satellites in the geostationary satellite orbit (GSO) to provide cost-effective, two-way voice, medium- and high-speed data, image, video and video telephony communications service to both business and individual users. Direct access to the satellites will be available on demand throughout the world via inexpensive ultra small aperture terminals (USATs). SPACEWAY™ is a high capacity, high quality, yet very versatile system. Figure 1 provides a summary of the performance available with each satellite. A two satellite regional configuration would therefore enable over 230,000 simultaneous telephone calls at 16 Kbps. The all digital 16 Kbps circuits utilized for telephony will ensure consistent high quality voice channels.

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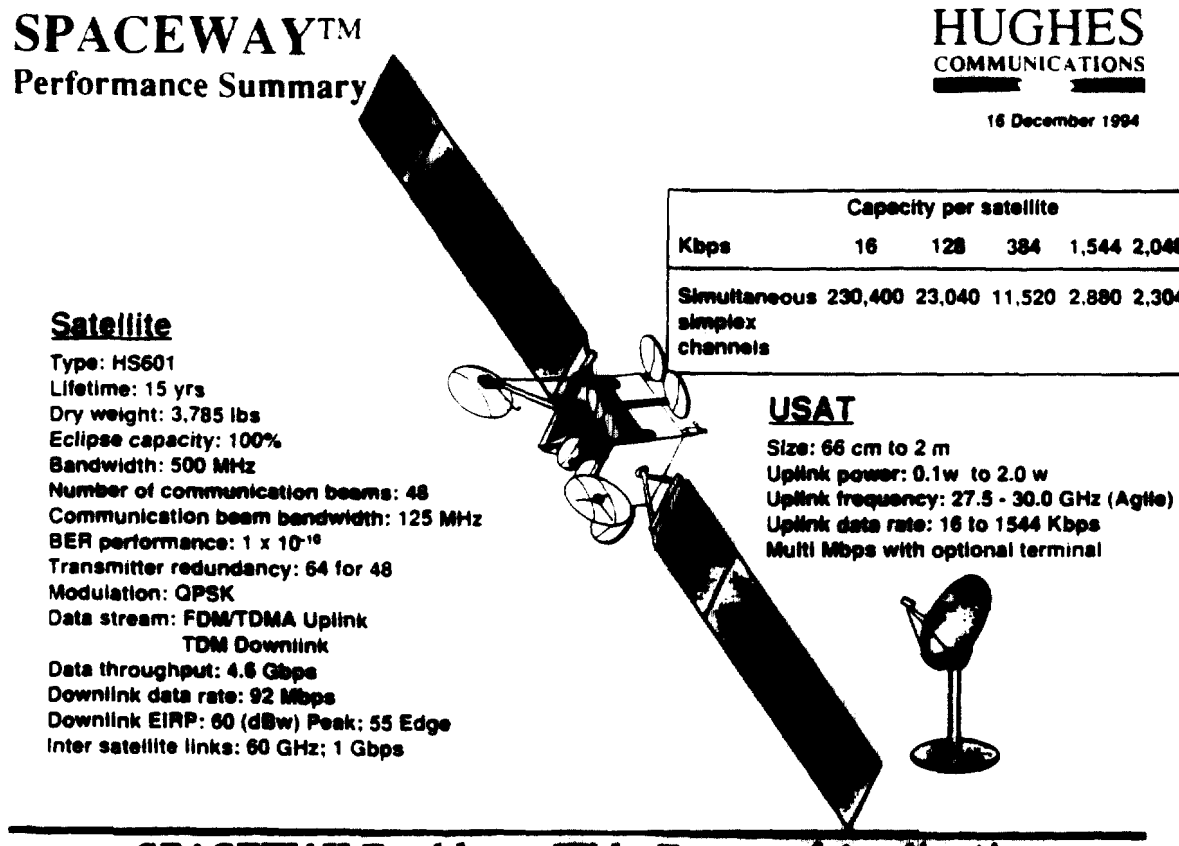
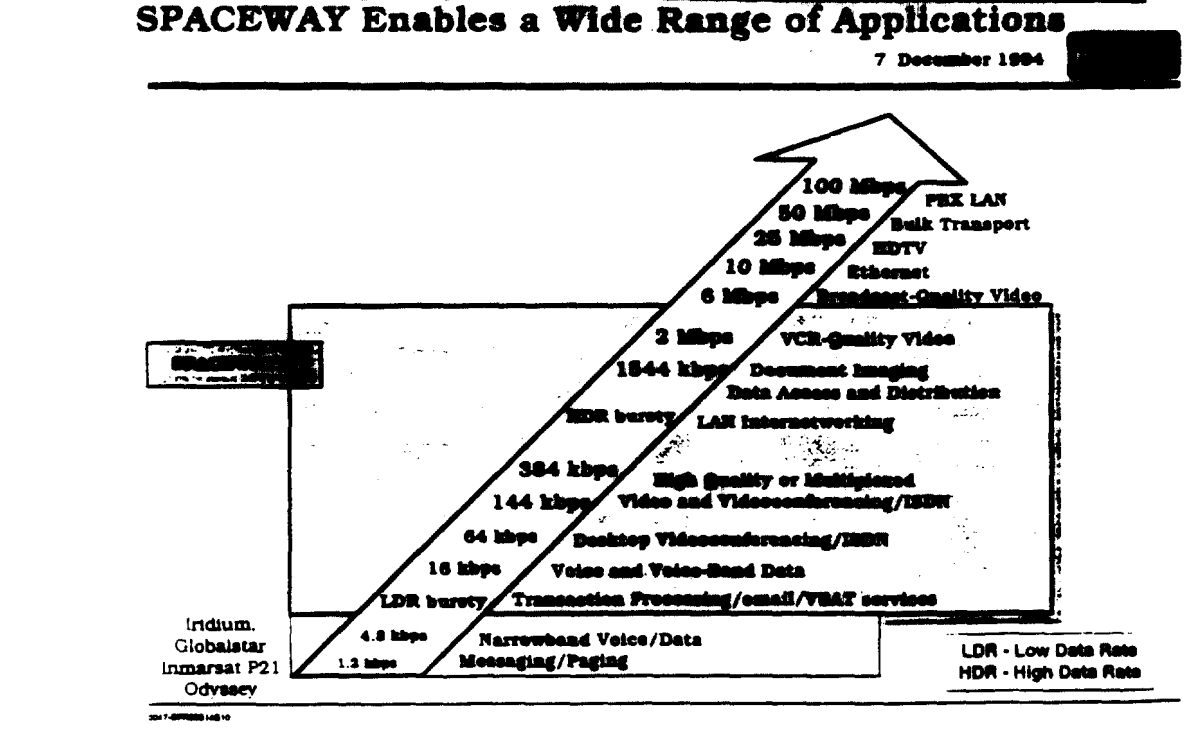
[1] Application filed by Hughes Communications Galaxy, Inc. with the Federal Communications Commission on 26 July 1994.

The high capacity of each SPACEWAY™ satellite is focused through the spot beams on the populated areas of the world thereby creating a significant cost advantage in the delivery of its telecom services. The flexibility of applications available through SPACEWAY™ is achieved through its broad range of data rates and is illustrated in Figure 1A.





The SPACEWAY™ network is different from other proposed global networks in that its geostationary orbit location makes it a truly market driven system: each satellite will make available extensive telecom services to hundreds of millions of people within the continuous view of that satellite, providing immediate capacity within a specific region of the world. SPACEWAY™ will be implemented in a phased, regional approach beginning in 1998, expanding into a network of four interconnected regional systems: (i) North America, (ii) Asia Pacific (iii) Central/South America, and (iv) Europe/Africa. The SPACEWAY™ network will provide in each of these regions the same low-cost, ubiquitous communications services at data rates up to multiple megabits per second, while also providing worldwide connectivity.

In developing countries, SPACEWAY™ will offer essential domestic and international telephone and facsimile services that will be seamlessly integrated into the public switched telephone network ("PSTN"). The system will offer domestic service, intra-regional service (e.g., Japan to Korea), and global international service (e.g., United States to Japan). SPACEWAY™ will offer high bandwidth services for a variety of consumer and business applications, both for countries with existing telecom infrastructures and those with emerging needs for advanced services.

Figure 2 depicts the phased regional implementation of the SPACEWAY™ network. The first satellites in the SPACEWAY™ network will be operational in 1998. Each regional system will include two satellites. Our system plan accommodates the growth for up to four satellites per region. By the year 2000, the SPACEWAY™ network will provide global coverage and offer connectivity among all the regions of the world through the use of intersatellite links and satellite beams. For these reasons, Hughes believes that the SPACEWAY™ network will become an essential element in the establishment of the Global Information Infrastructure (GII) by the turn of the century.

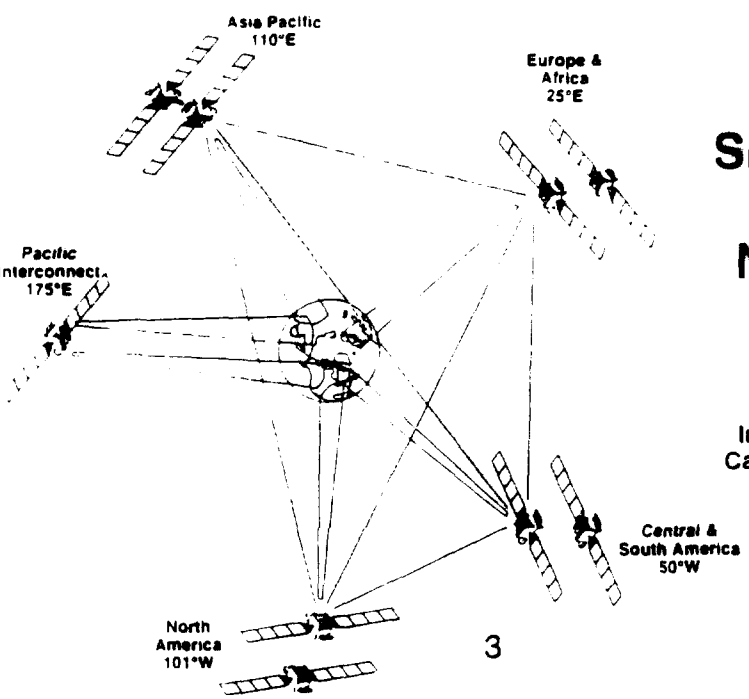


FIGURE 2

Spaceway Global Network

Phase 1

Orbital Locations

Initial Operating Capability by 2000

This innovative all-digital network will utilize state-of-the-art advances in satellite technology to provide full duplex interactive communications throughout the world. In addition to use of both narrow and wide area spot beams, its features include on-board signal processing, on-board switching, small, easily installed ground terminals, and digital transmissions at a variety of bit rates. Through a unique arrangement of intersatellite links (ISLs), SPACEWAY™ will create the first truly interconnected worldwide wideband network.

A key component of the system architecture is the Ka-band spot beam network. This technology will allow the use of extremely small end user terminals (approximately 66 cm) and provide a high degree of spectrum efficiency. Each spot beam nominally will use 125 MHz of bandwidth. Narrow spot beams (about 1°) with a footprint approximately 650 km. in diameter will cover most of the populated world land mass. In certain regions of low population density, wide spot beams (3°) will be used to cover areas about 1950 km. in diameter. The satellite design will permit reuse of frequencies up to twelve times. Thus, the 500 MHz of spectrum utilized by each satellite will result in an effective 6 GHz of useful bandwidth per satellite.

The system allows symmetric and asymmetric data communications at transmission rates from 16 Kbps to 1.544 Mbps, depending upon user requirements with the standard 66 cm terminal. Multi megabit per second applications can be accommodated with the SPACEWAY™ optional broadband terminal.

Each satellite will utilize a state-of-the-art on board switch/processor to provide individual end users with immediate access to the space segment, and to route transmissions within and between appropriate destination spot beams, as well as to interconnect with other satellites in the network. This "on demand" satellite service will be priced competitive, with many basic terrestrial telephone services especially in remote and underdeveloped areas, where basic telephone services are neither economically feasible nor available. In addition, the use of off-the-shelf digital video compression equipment or optional codecs built into the earth terminals will allow end users to utilize a high quality, two-way interactive video telephony service. Availability of such teleconferencing facilities at low cost should help lesser-developed countries to improve the delivery of vital services such as health care and education.

SPACEWAY™ will offer a dramatic advancement in the functionality and affordability of business networks relative to today's VSAT capability. For businesses, the SPACEWAY™ USAT both advances the state-of-the-art in VSAT networking, and brings satellite technology to the economic threshold of a greater universe of customers. SPACEWAY™ USATs offer complete mesh connectivity without the need for expensive hubs: in essence a "hubless" network. Thus, through low cost USATs, smaller businesses -- for whom today's VSATs are unaffordable - can take advantage of satellite networking without requiring a large number of sites to amortize hub costs.

SPACEWAY™ overcomes this limitation by providing worldwide coverage and global connectivity at Ka band. Furthermore, there are many areas of the world without access to Ka band satellite capacity that is currently needed to support VSATS.

SPACEWAY™ will accommodate most conventional VSAT applications, including retail point-of-sale transaction processing, on-line reservations and inventory/pricing information updates. In addition, SPACEWAY™ will offer a variety of wideband services including video telephony and conferencing (allowing multiple meeting sites and interconnection with terrestrial videoconferencing equipment and services), telecommuting (home computer to office LAN connection), medical and technical tele-imaging and CAD/CAM data and image transmission.

With its small size and low cost, the SPACEWAY™ USAT will make the benefits of satellite communications readily accessible to consumers. It is anticipated that consumers will use SPACEWAY™ for basic telephony and data communications, personal vidotelephony and high speed personal computer access to on-line services (such as Compuserve and Prodigy), as well as two-way interactive access to the wide array of multimedia information and entertainment services currently being developed for the "information superhighway" of tomorrow. The system will permit the advanced telecommunications and media industries to reach an even wider audience through a globally interconnected wideband network.

The SPACEWAY™ network represents a giant stride forward for the transmission of data. The incorporation of on-board satellite switching/processing, multi-spot beam coverage, and advanced ground terminal semiconductor technology, will allow small, inexpensive end user terminals, immediate and on-demand access to space segment and very fast data transmission. For many applications, such as sending medical images (x-rays) to and from remote clinics, short transmission time is critical. The SPACEWAY™ network can dramatically reduce the retransmission time of important data by providing transmission at rates more than 150 times faster than conventional telephone lines. The following chart displays this relationship between time, information content and bandwidth.

IMAGE	INFORMATION CONTENT	ORDINARY PHONE LINE	SPACEWAY™ 384 Kbps	SPACEWAY™ 1.5 MBPS (T1)
Digitized Photo	1.0 megabit	1.7 min.	2.6 sec	0.7 sec
CAD/CAM	2.0 megabits	3.4 min.	5.2 sec	1.4 sec
CT Scan	5.2 megabits	9.0 min.	13.5 sec	3.4 sec
X-Ray	12.0 megabits	21.0 min.	31.3 sec	7.8 sec

In sum, the on-demand high-speed data transmission capability of the SPACEWAY™ network will facilitate an array of applications. In addition to those described above, many other could be made available through third-party service providers.

The SPACEWAY™ network will provide interconnected, bandwidth on demand services to virtually every populated area of the world. In this regard, the service area of the SPACEWAY™ network is similar to that of many of the low earth orbit ("LEO") satellite systems that have been proposed. The SPACEWAY™ network is different from these LEO systems in two significant respects: it is more spectrally efficient and it will not forestall the development of other geostationary satellite systems using the Ka band at other orbital locations. It is a geostationary satellite system that operates from a total of six orbital locations and complies with the United States Federal Communications Commission's 2° spacing policies. Thus, it is anticipated that it will be compatible with any other Ka band FSS system that may operate at any other geostationary orbital location that is at least 2° away. Assuming uniform 2° spacing around the world, making 180 orbital slots available, the 2.5 GHz that has been proposed for SPACEWAY™ could be reused to effectively provide 435 GHz of Ka band spectrum for other satellite services. No LEO system that has been proposed to date has offered this type of an opportunity for frequency reuse. In sum, unlike LEO satellite systems that have been proposed at Ka band, the SPACEWAY™ network supports the entry of multiple service providers at all or part of the 2.5 GHz that is available at Ka band.

2. Space Segment Characteristics

The deployment of the multibeam satellites at geostationary orbit will be accomplished on a phased regional implementation and is illustrated in Figure 1. The proposed assignment of frequencies and polarizations to satellite beams, the geographic coverage provided by these beams, and a description of the other satellite parameters are given below.

2.1 Frequency and Polarization Assignments

The SPACEWAY™ global network will utilize the 17.7 to 20.2 GHz portion of the Ka band for space-to-Earth (downlink) transmissions, and the 27.5 through 30.0 GHz portion of the Ka band for Earth-to-space (uplink) transmissions. This spectrum has been allocated on a worldwide basis for the Fixed-Satellite Service ("FSS").

The overall frequency plan for each of the seventeen satellites in the SPACEWAY™ network is presented in Figures 3, 4, and 5.

A WIDE RANGE OF AFFORDABLE APPLICATIONS

Infrastructure Enhancement

In most developing countries, making basic telephony available to all citizens is a national priority. However, even the most advanced terrestrial system is challenged to provide service in regions with low population density, poor economies, or difficult topography. SPACEWAY technology can readily overcome these constraints. The system offers telephone and facsimile services that can significantly extend the telecommunications infrastructure in developing countries.

Universal Access. The system provides a cost-effective means to achieve universal service, especially in rural and remote regions. An example of how a region with a poor or non-existent telecommunications infrastructure would be served by the system is the SPACEWAY Telecommunications Center (STC). By placing an STC in a town or village, individuals can immediately make or receive voice, video, data and fax transmissions to and from anywhere in the world.

Affordable Telephony. SPACEWAY provides affordable telephony and data communications to assist economic and industrial development. Unlike mobile telephony systems, SPACEWAY uses long-life, high-capacity geostationary satellites that focus all communication beams on populated regions. This approach will offer the most efficient, low-cost service, competitively priced with domestic and international terrestrial networks. As well, the cost per voice circuit for the SPACEWAY System will be 10 to 20 times lower than proposed mobile systems.

High Quality Telephony. The system's all digital 16 Kbps voice channels incorporate echo cancellation to ensure excellent voice quality — noticeably better than the mobile alternative at 5 Kbps.

Rapid Deployment. Because the system is satellite-based, it can deliver rapid infrastructure deployment regardless of population density, economic conditions or difficult topography.

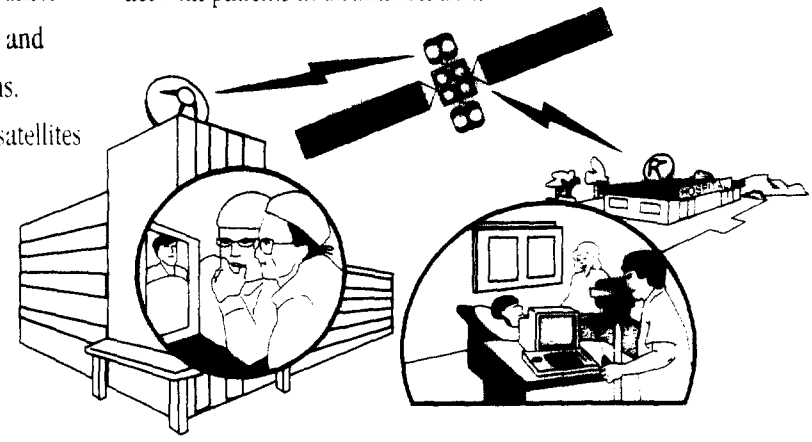
New Generation of VSATs. Improved functionality and lower capital and operating costs will enable more businesses to electronically connect multiple locations for transactions such as retail point-of-sale and inventory control.

Interactive Multimedia

SPACEWAY offers broadband services for a variety of consumer and business applications for those who have emerging needs for advanced services, but have no access to terrestrial high data-rate lines.

Computer Networking. Organizations can unite operations at multiple locations by joining their remote LANs into a single high-speed network through SPACEWAY.

Tele-Imaging. Physicians can use the system to transmit high-resolution images (X-rays), allowing specialists to interact with patients at distant locations.



The Spaceway™ System

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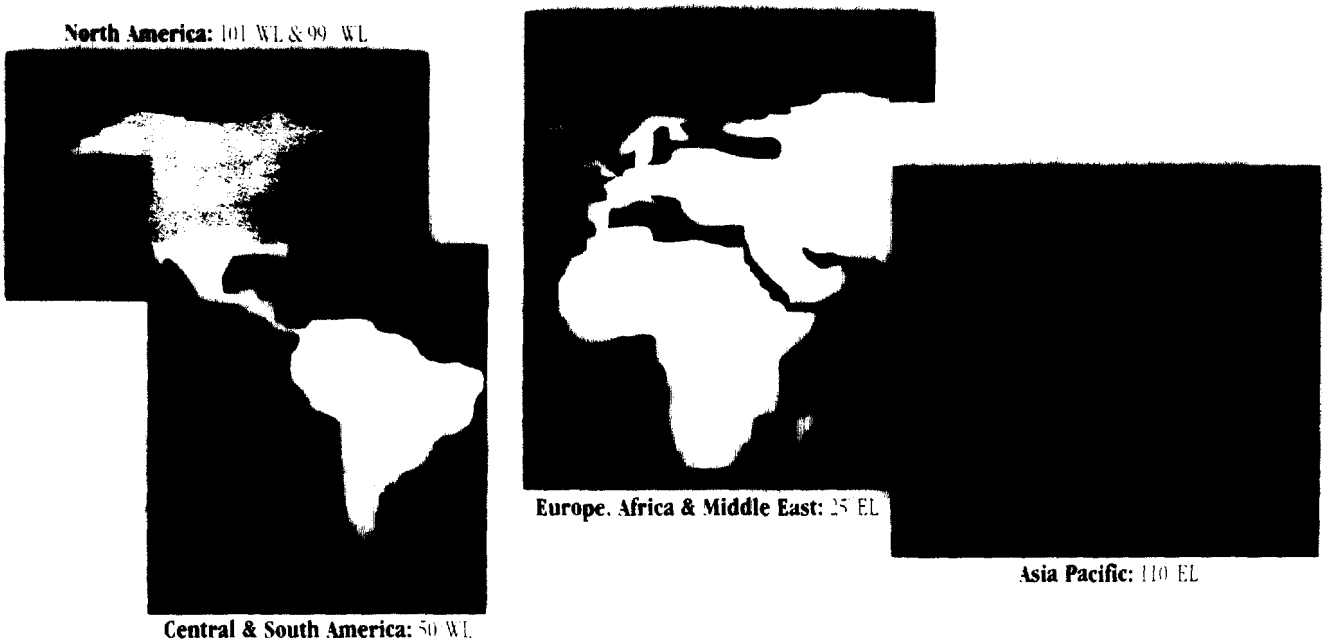
A REVOLUTION IN COMMUNICATIONS

SPACEWAY™ is a wireless expressway that will provide businesses and consumers around the world with affordable access to a variety of interactive, high-speed and high-quality broadband telecommunications services. SPACEWAY utilizes a global system of geostationary satellites that will allow users to transmit and receive voice, video, audio, and data hundreds of times faster than conventional telephone lines. Access to the system is easy and instantaneous through use of a low-cost ($1,000), two-way 26-inch antenna. SPACEWAY will offer business users a wide variety of applications, including desktop video telephony and conferencing, computer networking, technical tele-imaging, CAD CAM transmission and high-speed, low-cost access to the next generation of on-line multimedia data bases at rates from 16 Kbps to 2 Mbps and higher, if desired.

The SPACEWAY System will play two key roles when service begins in 1998. The first is infrastructure enhancement: to provide basic telephony to underserved areas of the world, and to allow these areas regional and global telecom access. The second is interactive multimedia: to provide advanced communications to the global marketplace, where huge quantities of information must be accessed and shared electronically.

REGIONAL FOCUS... WORLDWIDE CONNECTIVITY



SPACEWAY is a Fixed Satellite System (FSS) using spacecraft in geostationary earth orbit (GEO). Operating in the Ka-band spectrum, SPACEWAY will consist of four interconnected regional satellite systems providing service to nearly all of the world's population. The first regional system will offer service in 1998, with the other three regions going on-line by the year 2000. SPACEWAY provides "bandwidth-on-demand"—the ability to transmit and receive voice, video, audio, and data at any time from any place—at up to two megabits per second. It seamlessly integrates into the terrestrial infrastructure, enabling SPACEWAY customers to communicate with anyone served by the terrestrial network.

Interactive Distance Learning. Users can establish low-cost, two-way education and training programs that bring together students at multiple sites and instructors who are miles away.

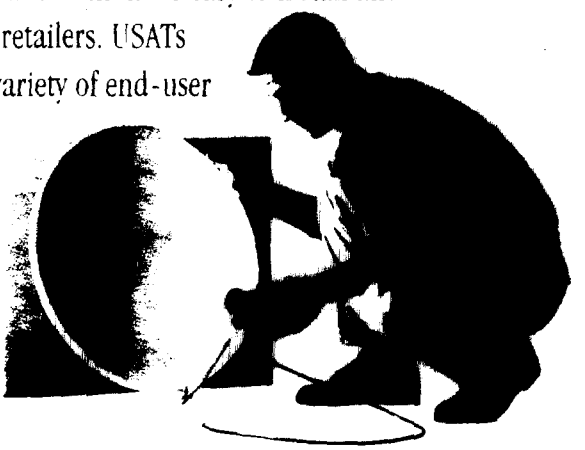
Digital Libraries. SPACEWAY provides rapid access to on-line multimedia information.

Telecommuting. The system's high-speed, interactive data transfer capacity makes rapid intellectual exchange between office and home effective and easy.

Videoconferencing. SPACEWAY delivers high-speed ISDN-type communications for desktop videoconferencing between office locations.

EASY ACCESS... SEAMLESS CONNECTIVITY

SPACEWAY end-users will access the system with an inexpensive Ultra Small Aperture Terminal (USAT), utilizing a 26-inch diameter dish or antenna. Costing less than $1,000, this terminal is easy to install and will be available through commercial outlets and consumer electronics retailers. USATs incorporate complete digital electronics that can interface with a wide variety of end-user equipment such as telephone, facsimile, personal computer and video. The system is fully compatible with a wide range of terrestrial transmission standards such as ATM, ISDN, Frame Relay and X.25. The SPACEWAY USAT represents the next generation in satellite communications technology and provides bandwidth-on-demand, hubless full-mesh networking, a wide range of data rates and full terrestrial compatibility.

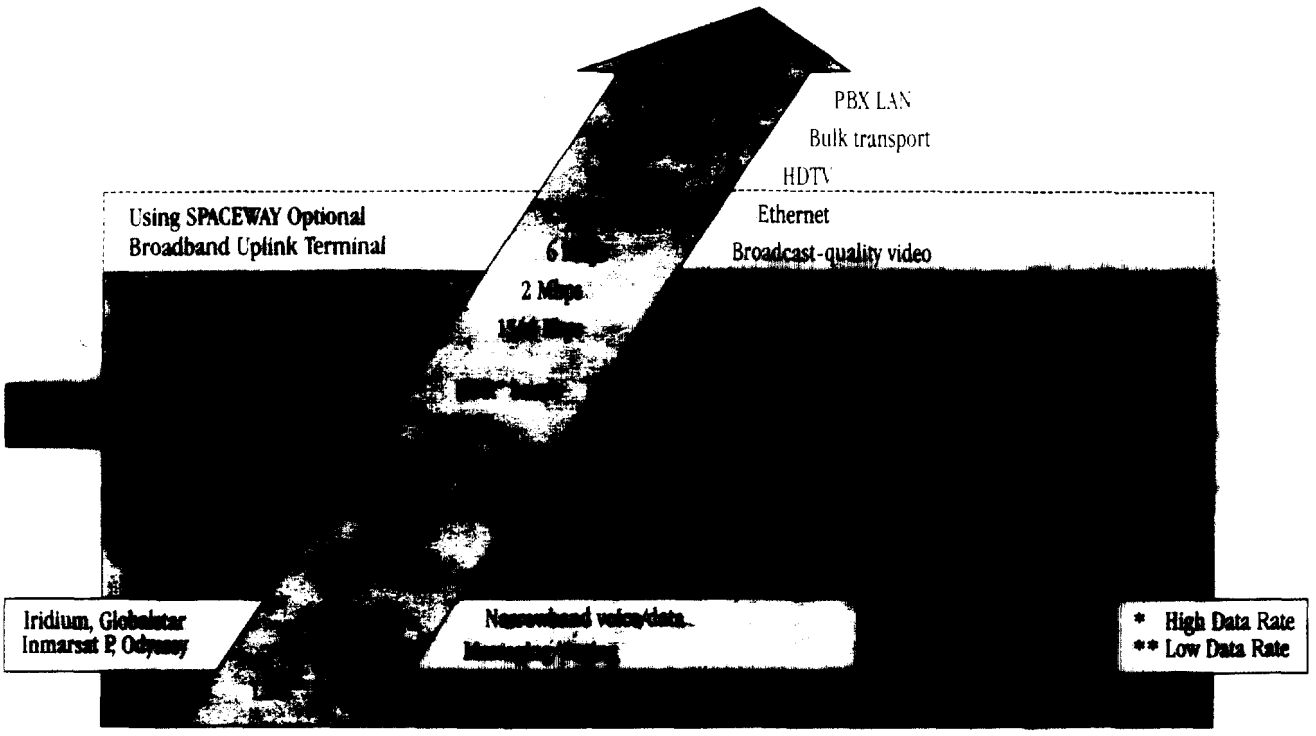


HUNDREDS OF TIMES FASTER

SPACEWAY transmits and receives hundreds of times faster than conventional telephone lines. An optional broad-band uplink terminal will support applications requiring up to 20 megabits per second.

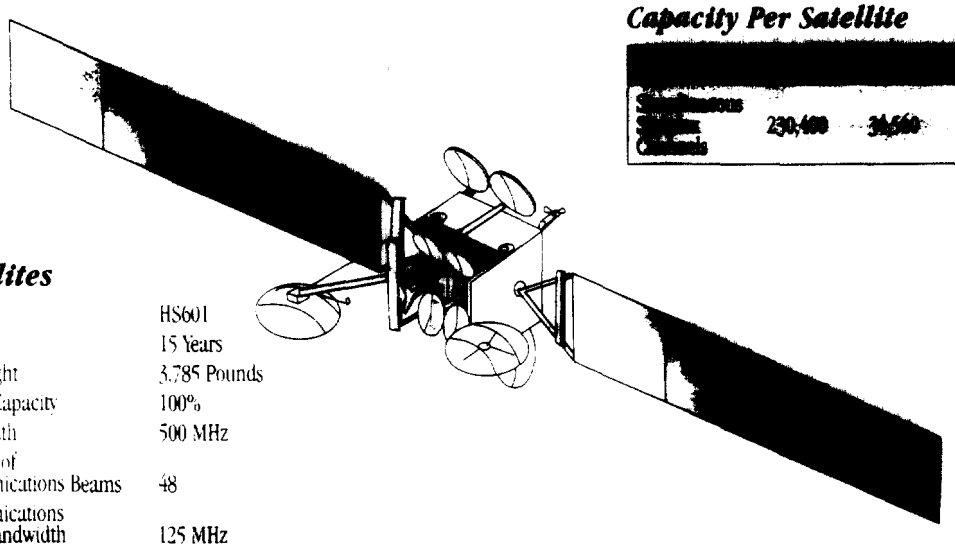
Digitized Photo	1 Megabit	2.5 Minutes	2.6 Seconds	0.7 Seconds
CAD/CAM	2 Megabits	5.0 Minutes	5.2 Seconds	1.4 Seconds
X-Ray	12 Megabits	25.0 Minutes	31.3 Seconds	7.8 Seconds
Digital Library	Washington Post Sunday Edition	28.0 Minutes	41.6 Seconds	10.4 Seconds

REMARKABLE VERSATILITY... BANDWIDTH-ON-DEMAND



The SPACEWAY System offers the customer instant access to a broad range of applications at selectable data rates, easily matched to their specific application. Charges will be based on the resources used by the customer. This translates into a high degree of functionality at affordable costs.

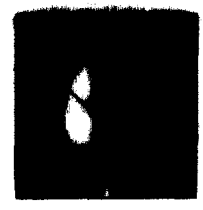
HIGH PERFORMANCE... HIGH CAPACITY



Capacity Per Satellite

Satellites

Type	HS601
Lifetime	15 Years
Dry Weight	3,785 Pounds
Eclipse Capacity	100%
Bandwidth	500 MHz
Number of Communications Beams	48
Communications Beam Bandwidth	125 MHz
BER Performance	1 x 10 $^{-9}$
Transmitter Redundancy	64 for 48
Modulation	QPSK
Data Stream	FDM TDMA Uplink, TDM Downlink
Data Throughput	4.6 Gbps
Downlink Data Rate	92 Mbps
Downlink EIRP	60 (dBw) Peak; 55 Edge
Inter-Satellite Links	60 GHz; 1 Gbps



Ultra Small Aperture Terminal (USAT)

Size	66 cm to 2 m
Uplink Power	0.1w to 2.0 w
Standard Terminal	
Uplink Data Rates	16 Kbps to 2.048 Mbps
Downlink Data Rates	16 Kbps to 92 Mbps
Optional Uplink Terminal	
Uplink Data Rates	Up to 20 Mbps

The SPACEWAY ™ System, Hughes Communications, Inc. PO Box 92424, Los Angeles, CA 90009 Phone:(310) 364-4840 Fax: (310) 364-4841